Overview of Telehealth Activities in Speech–Language Pathology

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Abstract

It is estimated that 10% of the world's population, approximately 650 million people, have some form of disability. Population growth, aging, and medical advances that preserve and prolong life have increased demands for health and rehabilitation services. Recent predictions indicate a shortage of speech–language pathologists and other rehabilitation specialists to provide care for individuals with disabilities. The application of telemedicine and telehealth technologies offers effective solutions to this challenge. An extensive literature review was conducted that included technical reports, websites, publications from the American Speech-Language-Hearing Association, and peer-reviewed journal articles of telehealth applications in speech–language pathology. Various applications of telehealth in speech-language pathology are described including types of technology, patient and clinician satisfaction, advantages of using telehealth, challenges and barriers to application, and future directions. This review provides a strong foundation for broader applications of telehealth technologies in this area of healthcare.

Key words: *telehealth, telepractice, telerehabilitation, speech–language pathology, communication disorders, swallowing disorders, dysphasia, speech therapy, language therapy*

Introduction

Speech and language disorders affect one's ability to talk, understand, read, and write, and may range from a few speech sound errors to a total loss of the ability to use speech to communicate effectively. Dysphagia or a swallowing disorder is a serious health problem that can be life-threatening. Speech–language pathologists (SLPs) evaluate, diagnose, and treat communication and swallowing disorders in individuals of all ages, from infants to the elderly. The American Speech-Language-Hearing Association (ASHA) is the professional, scientific, and credentialing association for more than 130,000 SLPs, audiologists, and speech, language, and hearing scientists in the United States and internationally.[1]

A significant problem in many geographical areas is a shortage of SLPs. According to the U.S. Bureau of Labor Statistics, employment of SLPs is expected to grow 11% from 2006 to 2016, about as fast as the average for all occupations.[2] A healthcare survey conducted by ASHA in 2005 identified an increase in vacancies from 25% in 2002 to 40% in 2005 for SLP positions across all healthcare settings. The largest increase in vacancies was in home health.[3] A survey of schools conducted by ASHA in 2006 identified school districts with significant personnel shortages; 68% of respondents reported that job openings were more numerous than job seekers.[4]

ASHA's position is that telepractice or telehealth is an appropriate model of service delivery for the profession of speech–language pathology, and may be used to overcome barriers of access to services caused by distance, unavailability of specialists and/or subspecialists, and impaired mobility.[5] Research and demonstration projects have provided evidence that telehealth is a feasible, effective, and appropriate model for providing SLP services to a broad range of patients. According to a review of the literature, clinicians in Australia, Canada, Greece, Ireland, Japan, the United Kingdom, the United States, and Sweden are exploring the possibility of using telehealth to diagnose, assess, and provide treatment to individuals with communication and swallowing disorders who otherwise may not have access to these services. The objective of this paper is to provide an overview of the literature.

Materials and Methods

An extensive literature search was conducted of current available resources including peer-reviewed journal articles, professional

and lay articles, abstracts of presentations, and policy statements by associations. The search included the following terms: telehealth, telemedicine, telepractice, telerehabilitation, speech–language pathology, communication disorders, speech therapy, language therapy, swallowing disorders, and dysphagia.

Results

This literature search resulted in 40 articles that are tabulated in the Appendix. In addition to policy documents, the existing literature consists primarily of pilot studies and anecdotal accounts of telehealth applications rather than large, well-controlled, randomized clinical trials. The following is a discussion of topics that were gleaned from each source.

Patient Candidacy

Patient candidacy for the telehealth model of service delivery in SLP is typically determined on a case-by-case basis utilizing careful selection criteria. While not exclusionary, the following factors are typically considered: (1) ability to sit in front of a monitor and attend to the clinician; (2) ability to see material on a computer monitor; (3) ability to follow directions to operate the equipment; (4) ability to sit in front of a camera and minimize extraneous movements to avoid compromising the image resolution; (5) manual dexterity to operate a keyboard if needed; (6) hearing acuity; (7) cognitive ability; (8) speech intelligibility; (9) comfort level with technology; (10) willingness of patient or family/caregiver to participate; (11) cultural/linguistic considerations such as the availability of an interpreter if needed; and (12) access to and availability of technical resources if needed.[6]

Investigators at the Mayo Clinic reported the following challenges for SLP consults in their early experience with telemedicine: (1) the inability to assess muscle strength and musculoskeletal tension and to physically manipulate speech structures may result in omission of important information in patients with motor speech disorders; (2) eliciting sensitive case history information at-a-distance may be difficult when assessing patients with psychogenic speech disorders; and (3) patients with significant language or cognitive impairment may have difficulty grasping the interactive process over television monitors.[7]

Clinicians at the Rehabilitation Engineering Research Center on Telerehabilitation at the National Rehabilitation Hospital (NRH) reported that age, education, technology experience, and gender did not significantly affect the difference between performance of brain-injured patients on a standardized speech-language evaluation conducted face-to-face versus via videoconference.[8] Stroke-related symptoms such as poor attention, severely impaired comprehension, poor vision, and motor impairment may adversely affect a patient's ability to participate in a telehealth session. However, "in-home" delivery of speech–language services may be most appropriate for this population if family members, caregivers or paraprofessionals are available and willing to provide assistance.[9–11]

Applications

A variety of venues are involved in the delivery of SLP services via telehealth, including medical centers, rehabilitation hospitals, specialty cancer care centers, satellite clinics, residential healthcare facilities, rural community health centers, Veterans Affairs Medical Centers, military medical facilities, universities, patient's homes, schools, and child care nurseries. The majority of applications are aimed at reaching out to underserved populations in remote or rural areas within a district, county, state, province, or country to evaluate and/or treat speech, language, cognitive–communication, and swallowing disorders (see Appendix for a summary of applications including types of services and technologies used).

NEUROGENIC COMMUNICATION DISORDERS

SLPs have used the telehealth model to provide services to patients with aphasia, dysarthria, apraxia, cognitive–communication disorders, and dementia resulting from cerebrovascular disease (CVA), traumatic brain injury (TBI), Parkinson's disease, cerebral palsy, and multiple sclerosis. Telehealth offers the potential to extend the continuum of care and improve clinical outcomes for these patients, particularly in light of insurance reimbursement challenges and shortened lengths of hospital stays.[10]

Early application of telecommunications technology in SLP focused on diagnosis and treatment of neurogenic communication disorders. In 1976, a "Tel-communicology" healthcare delivery system for veterans was developed to meet expanding demands, upgrade services, and overcome logistic problems. This system was designed to enhance rather than replace traditional programs to treat patients with communication disorders including aphasia and dysarthria.[12] Beginning in 1987, investigators in Mayo Clinic facilities provided SLP telemedicine consultations for patients with communication disorders including dysarthria, apraxia, and cognitive–communication impairment. They concluded that telemedicine provides an appropriate medium for speech–language consultations that is reliably accurate in identifying various acquired neurogenic and psychogenic speech disorders.[7] In 1992, clinicians at the Veterans Affairs Medical Center in Martinez, California conducted a simulation study to compare face-to-face with "remote conditions" in the appraisal and diagnosis of aphasia, apraxia, dysarthria, and dementia. The agreement in diagnosis among appraisal conditions was 93% to 94%. Results sug-

gested that either television or computer-controlled video laserdisc by telephone could be substituted for face-to-face sessions.[13]

Since these early studies, many telehealth applications for neurogenic communication disorders have been reported. Investigators at the Rehabilitation Engineering Research Center on Telerehabilitation at the NRH have been at the forefront in technology innovations to deliver services to patients with CVA and TBI.[8,10,14,15] Clinicians in Australia conducted a telerehabilitation pilot study with 19 participants with dysarthria. Results suggested that reliable assessment of motor speech disorders over the Internet is possible in adults with acquired neurological impairment with additional refinement of their technology and assessment protocols.[16] An investigator at the Center for Health and Disabilities Research, National Rehabilitation Hospital, reported that pilot study results with 24 poststroke patients suggested that assessment of a patient's functional communication using videoconferencing equipment at a transmission speed of 384 kilobits per second (Kbps) was equivalent to a face-to-face encounter. A randomized, double-crossover agreement design was used with carefully devised criteria for a telemedicine equivalence trial. The investigator outlined methodological improvements over previous telerehabilitation studies and cited recommendations for future studies.[17]

In anecdotal reports, the Speech Therapy Department at St. Alexius Medical Center in Bismarck, North Dakota, provided care through their Tele-Care Network to patients in rural communities who suffered a stroke and lacked access to local SLP services.[18] A speech pathologist in the Department of Veterans Affairs in Lexington, Kentucky, reported treatment gains, good patient response, and cost savings with the use of videophones to treat anomia.[19] Clinicians in Vasterbotten, Sweden, reported positive results and high patient satisfaction with interactive and store-and-forward telehealth speech–language rehabilitation for adults with aphasia.[20]

Telehealth is being used to address the problem of unfilled SLP positions in home healthcare agencies.[11,21,22] One of the many important responsibilities of SLPs in this setting is to evaluate and treat patients recovering from speech, language, cognitive, and swallowing disorders associated with CVA. Timely and regular rehabilitation services are critical to maximize the potential for recovery of function or use of compensatory strategies to enable the patient to be as independent as possible including the possibility of returning to the workforce.

FLUENCY DISORDERS

Telehealth is particularly advantageous in the treatment of fluency disorders because there are few specialized centers for treating stuttering and long-term follow-up for maintenance is frequently required. Early stuttering should be treated efficaciously in the preschool years to prevent progression to a long-term form. Although the Lidcombe Program of Early Stuttering Intervention has been shown to be an effective treatment, many children in Australia who live in rural and remote areas do not have access to this program. Because it is implemented by parents under guidance of an SLP, it is easily adaptable to telehealth delivery. A series of research trials provided evidence that use of low-tech telehealth technology (training videos, recorded speech samples, telephone, e-mail) yielded satisfactory clinical outcomes; however, in one study, the results were obtained with lengthier treatment times and at higher cost compared to traditional clinic-based delivery.[23,24]

Researchers at the Australian Stuttering Research Centre at the University of Sydney conducted a Phase 1 trial to investigate the viability of telehealth delivery of the Camperdown Program with adults who stutter. This behavioral treatment involving speech restructuring was conducted remotely via telephone and e-mail contact between clinician and patient. Preliminary data from 10 adults suggested that the Camperdown telehealth program has potential to provide efficacious treatment for patients who do not have access to traditional face-to-face treatment.[25]

A study was conducted with children and adolescents who stutter to assess the feasibility and outcome of delivering services at-a-distance between a Montreal pediatric tertiary care center and a primary care center in a remote area in Northern Quebec, Canada. Results demonstrated that interactive videoconferencing is a feasible and effective model and resulted in improved fluency in all participants.[26]

Clinicians at the Institute for Stuttering Treatment and Research at the University of Alberta in Canada used videoconferencing to provide services to adults in geographically remote areas following their discharge from intensive treatment at the Institute. Clinical measures of communicative performance, verbal reports from patients, and clinician judgments indicated that treatment goals were met and patients were satisfied with their telehealth treatment.[27,28]

VOICE DISORDERS

Speech pathologists in Australia used an Internet-based (128 Kbps) telerehabilitation application to deliver the Lee Silverman Voice Treatment (LSVT) to 10 participants with Parkinson's disease (PD). Patient access to this treatment was limited because of distance, the limited availability of certified LSVT clinicians in rural/remote areas of Australia, and patient mobility challenges that preclude or impede their travel to a healthcare facility in both urban or rural environments. Treatment outcomes data demonstrated that the online treatment was feasible and effective.[29] In an anecdotal report, telehealth sessions combined with home visits enabled clinicians with the Visiting Nurse Service of New York-Home Care to offer the LSVT program to

patients with PD. The intensive four-sessions-per-week schedule of this evidence-based program often makes it unavailable to homebound patients because of access difficulties or heavy caseload demands.[21]

Following a successful proof-of-concept study with 51 participants in Hawaii, a vocal rehabilitation program was deployed from Tripler Army Medical Center in Honolulu to treat patients diagnosed with voice disorders in a U.S. Naval Hospital in Japan.[30,31] The use of video teleconferencing via Integrated Services Digital Network (ISDN) lines (at 384 Kbps) provided patients with access to services not available in their military medical facility. Preliminary data indicated that clinical outcomes were comparable to providing therapy in-person.

Investigators in Australia validated an Internet-based telerehabilitation system designed to assess patients following surgical removal of the larynx because of cancer. Greater than 80% agreement was reported between online and face-to-face assessments of oromotor, swallowing, and communication outcomes of 20 patients postlaryngectomy; however, visualization of the stoma was reported to be poor. Assessments were conducted at a bandwidth of 128 Kbps.[32]

An SLP in a specialty cancer care center in Manitoba used telehealth technology to provide voice and speech therapy, tracheoesophageal voice prosthesis management, psychosocial and peer support, and education for patients, family members and local healthcare professionals. Telehealth addressed the challenge of providing postlaryngectomy follow-up and rehabilitation for patients in rural or remote communities in Manitoba where access to specialized head and neck cancer expertise is often unavailable.[33]

DYSPHAGIA

Patients who are at risk for dysphagia should be thoroughly evaluated because impaired swallowing can result in significant morbidity and mortality. However, subspecialists in dysphagia may not be available in small rural communities or in remote areas. In addition to a clinical evaluation, instrumental examination (e.g., videofluoroscopic, fiberoptic endoscopic) is routinely used to identify underlying variables and determine appropriate management strategies for the swallowing problem. Investigators at the University of Illinois developed a program using video transmission over a T1 line that permits real-time, remote, interactive evaluation of oral/pharyngeal swallowing function. A custom interface enabled an expert SLP at the controlling site to direct a modified barium swallow study remotely and view and interpret in real-time the videofluoroscopic images captured in a hospital radiology suite.[34]

In anecdotal reports, an SLP at the University of Kansas Hospital mentored a colleague at a rural site in Kansas in performing modified barium swallow studies utilizing a videofluoroscope that attached directly to a Polycom F/X system. The cooperative venture provided an invaluable diagnostic service to patients in an underserved rural area of Kansas and eventually enabled the local clinician to complete the swallow studies independently.[35] An SLP with the Visiting Nurse Association Health Services in Port Huron, Michigan, monitored her patient through their telehomecare program after discharging him from in-home dysphagia therapy. The services, which were considered adjunct to the therapy already provided, resulted in significant improvement in the patient's swallowing function. Without telehomecare, the follow-up services would not have been possible since monitoring or maintenance is not considered a skilled service that warrants in-home visits.[11]

CHILDHOOD SPEECH AND LANGUAGE DISORDERS

There has been greater awareness of and increased emphasis on the importance of early identification and diagnosis of speech and language disorders. When the Individuals with Disabilities Education Act (IDEA) was implemented in 1990 mandating special education and related services to all eligible children with disabilities, rural schools were faced with personnel shortages and problems with recruitment and retention. In Oklahoma, a metropolitan rehabilitation hospital, a rural hospital, and a rural school formed a partnership to test the outcomes and acceptance of teletherapy in a public school.[36] In North Dakota, the Center for Persons with Disabilities located at Minot State University developed a program to provide speech–language therapy through interactive videoconferencing in remote areas of North Dakota where services were otherwise limited or nonexistent because of SLP personnel shortages.[37]

Early intervention can reduce the negative effects of childhood speech–language disorders such as academic difficulties. Children with speech and language disorders in rural and remote areas may be at a disadvantage because of poor access to SLP services. Results of a pilot study in Australia suggest that an Internet-based assessment protocol delivered via video teleconferencing through a 128 Kbps link has potential to provide a clinically reliable method for assessing pediatric speech disorders.[38] In the United Kingdom, clinicians are using videoconferencing technologies to deliver speech–language therapy remotely to support services to children with communication difficulties in mainstream schools.[39] In Belfast, SLP services were provided to preschool children in a nursery and in their homes with an interactive audiovisual interface, computers, and an ISDN 2 line (128 Kbps). "Televisits" allowed parents to participate more fully in their child's therapy program and gain a greater understanding of their child's communication development by observing them in the nursery setting. Clinicians were able to observe the child's communication environment in an unobtrusive manner and provide guidance to parents.[40] These projects demonstrate that telehealth is a viable treatment

option for children with special needs and can be used to support the delivery of speech–language therapy services in the schools.

Technology

TELEHEALTH MODELS OF SERVICE DELIVERY

The dynamic nature of communication, problem-solving, and behavior modification often necessitates synchronous transmission for "real-time" interactive evaluation and treatment of communication disorders. Studies have demonstrated that VTC is a viable and effective method for providing SLP services at-a-distance.[7,8,14,16,26,27,29,31,33,34,36,37,39,40] Auditory/verbal/visual interaction is essential for most procedures or at least preferred over audio only connections to enhance a sense of clinician "presence" and to facilitate rapport with patients.

Although the majority of SLP applications utilize VTC technology, store-and-forward components have also been used as a primary or adjunctive means of delivering services.[12,16,20,23,25,29,32,34,38,41]

EQUIPMENT AND TRANSMISSION MEDIUMS

An important consideration in equipment selection is the existence of the infrastructure or network across which they connect. Equipment, connectivity mediums, and bandwidth specifications vary according to the telehealth application and desired outcomes. Image and sound quality must be adequate to support the clinical procedure. Equipment used in SLP telehealth applications include telephones, videophones, fax machines, VTC units, computers for e-mail and video teleconferencing software and webcams, closed circuit televisions, and image scanners.[6] Technology used for telehealth SLP sessions should not distort or interfere with communication, or must do so only in a minimal and well-characterized way, since the quality of signals must support assessment and treatment of communication disorders.[8] Adequate bandwidth connection is imperative to ensure optimal audio and visual quality for clinical decision-making.

Intervention tools such as custom software are being developed to interface with VTC equipment to provide a "virtual desktop" for clinicians to administer therapy materials. For example, research engineers at the NRH developed a remote interactive touch screen which is highly intuitive and allows for fast and efficient control of a computer for therapy tasks and is particularly useful for patients with minimal computer experience or cognitive impairment.[10]

Investigators in Greece developed an innovative Web-based system of technology-assisted speech and language therapy tools and visual speech aids. The "Telelogos" system provides information, tests, report templates, a database for storing patient records and information, and e-learning applications.[42] According to usability studies, the system has potential to supplement the traditional delivery of speech therapy services. Pierrakeas et al.[41] discussed the use of "online collaboration environments" for various telehealth applications for speech therapy including: online group therapy for articulation disorders, aphasia and stuttering; clinical consultation with a multidisciplinary team; and online mentoring and continuing education. Both of these systems provide exciting possibilities for the global delivery of SLP services.

Response to Telehealth

PATIENT SATISFACTION

In addition to positive clinical outcomes, telehealth applications have yielded favorable patient feedback. With technological advancements and the ubiquitous use of computers in our daily lives, telehealth is assuming a desirable role in the delivery of healthcare, particularly for patients with an interest in technology. In Brennan et al's study,[10] 4 of 10 patients with left and right CVA reported that their comfort level was better in the telerehab condition because they felt "less self-conscious" when the clinician was out of the room or was "less distracted because the computer made it interesting." In a subsequent study with 40 participants with recent CVA or TBI, 34 of 40 participants expressed an interest in future use of VTC.[43] In a case report by Kully,[27] a patient who stuttered perceived the VTC format as challenging but manageable, and less demanding on fluency control than the telephone format which was the traditional medium for their long-distance maintenance program. In a study that compared in-person with remote delivery of a vocal rehabilitation protocol, both quantitative data on clinical outcomes and qualitative feedback were positive from patients who received therapy via the telehealth model (e.g., "The video sessions were just as good [as in-person]. It made it more interesting to see technology playing a part in medical sessions"). In fact, 16 of 16 qualitative patient comments on the telehealth model were positive.[30]

CLINICIAN SATISFACTION

Clearly, clinician satisfaction with the telehealth model is critical to its widespread acceptance and use. With positive patient responses, most SLPs engaged in telehealth have embraced the use of technology in their practice, despite admitting to initial skepticism. The lack of tactile feedback and cues may require creative problem-solving or even preclude the use of techniques that require "hands-on" delivery. However, investigators have reported that the absence of a clinician's physical presence does not compromise the "human element" or reduce the effectiveness of services provided via telehealth.[30,44] Suboptimal clinician satisfaction has generally been reported with telehealth systems that utilized low bandwidth transmission or

low-tech options for auditory perceptual ratings of speech characteristics that are inherently challenging to judge such as nasality or resonance, or visual perceptual ratings of oromotor movements or anatomical structures.[16,32]

Advantages of Telehealth

Telehealth offers the potential to deliver services in underserved and remote/rural geographic areas where they are not available, and in areas with shortages of specialists or lack of subspecialists. In several reports, telehealth also provided access to a university medical center. As a result, both patient and clinician benefited from the knowledge and expertise of a host of medical specialists. This was particularly advantageous for the clinician since practicing in a rural environment afforded few opportunities to interact with colleagues for professional growth and skill development.[34,35,45]

Telehealth not only increases the capacity to provide service in a "no-service" area but reduces the potential delay of service.[46] For example, the development of a telehealth program in rural Kansas eliminated wait time in scheduling modified barium swallow studies, decreased travel time, reduced patient fatigue, and improved accuracy of results. Patient follow-up was enhanced through timely discussion of results and recommendations.[35]

Telehealth can increase efficiency and cost effectiveness of delivering SLP services. Furthermore, telehealth meets the care needs of homebound patients with impaired mobility and allows for closer monitoring to determine when additional or follow-up services are needed.[11,21] Individualized home exercise programs can be developed to facilitate carryover of learned skills to the functional home environment.[46] The cost benefits associated with reducing staff time and minimizing travel expenses are significant for home healthcare and itinerant school services. Notably, personnel shortages are most critical in these settings.

Telehealth may increase the length of time SLPs can provide services to post-stroke patients. Carpenedo[21] reported that telehealth treatment allows the SLP to increase patient care time to meet the needs of the communicatively impaired homebound patient. Sub-acute patients with restorative potential can benefit from daily intervention with the use of telehealth services in addition to in-home visits. According to Brady,[11] a primary benefit in a home health agency has been the ability to increase available services. In spite of SLP shortages in rural areas, telehealth enables clinicians to cover a larger geographic area while providing more therapeutic services to patients.

Telehealth allows clinicians to provide adjunct treatment service to enhance clinical outcomes. Follow-up services, particularly after discharge from intensive or inpatient services can have a significant positive impact on functional outcomes.[14,21] In-home telehealth sessions also afford the opportunity to include family members and caregivers in the treatment program by providing education and training. Telehealth may provide a means that is cost effective for both the clinician and patient in order to economically extend services when insurance coverage ends.[10,11]

Challenges and Barriers to Telehealth Applications in Speech–Language Pathology

Challenges and barriers to widespread adoption of telehealth services are summarized in *Table 1*. In 2002, ASHA conducted a survey of 1600 members to sample their activities and attitudes with respect to telepractice (telehealth). Respondents were positive about the potential of telehealth. However, the barriers they perceived included cost, lack of professional standards, and lack of data on efficacy and cost effectiveness.[47]

Start-up costs including equipment purchase and installation as well as maintenance costs and connectivity charges can be prohibitive. However, with technological advances, these costs are decreasing. In addition, with the expansion of telehealth applications and demonstrated positive cost-benefits ratio, telehealth systems are becoming more widespread in hospitals, clinics, home healthcare agencies, and schools.

Many telehealth applications in SLP have been demonstration projects or funded research protocols. The lack of reimbursement presents

Table 1. Challenges and Barriers to Telehealth Applications in Speech–Language Pathology

Lack of funds for purchasing start-up equipment
Lack of infrastructure to support telehealth services
Lack of administrative, personnel, and/or technical support
Lack of reimbursement for telehealth services
Lack of professional and technical standards and guidelines to ensure appropriate application that does not compromise the standard of care expected for in-person clinical encounters
Lack of data on efficacy and cost-effectiveness of telehealth services
Licensure restrictions including the need to obtain multiple state licenses to practice across state lines
Ethical issues including protecting and preserving patients' privacy and confidentiality and complying with HIPAA regulations
Legal issues including risk management (e.g., ensuring clinical and technical competency; obtaining informed consent; using assistants and caregivers in providing services)

a challenge to sustainment of programs beyond the initial stages of research and development.[44] The majority of clinicians (71%) surveyed in 2002 reported that they were not being reimbursed for telehealth services; 15% reported reimbursement by private pay, 10% by private insurance, and 5% by Medicaid.[47] Fortunately, federal funds are being offered to support telehealth programs, particularly in rural health networks (e.g., grants from the Office for the Advancement of Telehealth). Furthermore, a request to the Centers for Medicare & Medicaid Services (CMS) was submitted by the American Telemedicine Association to add speech pathology/therapy procedures to the approved list of telehealth related CPT codes, and to approve SLPs as eligible telehealth providers through the physician fee scheduling process.

Denton[48] addressed legal and ethical issues associated with telepractice in SLP including state licensure, privacy and confidentiality, malpractice, competence, informed consent, and use of assistants. Current licensure requirements present a barrier to telehealth; obtaining multiple state licenses is required to practice across state lines. Licensure typically includes initial application and subsequent renewal fees as well as fulfilling examination and continuing education requirements that differ across states. If telehealth is to be a feasible means of providing services, the restrictive nature of interstate licensure requirements must be resolved. Potential solutions include the establishment of national regulations, Congressional action to regulate telemedicine licensure, reciprocity for the purposes of telehealth, or cooperation among states for multi-state licensure in telemedicine.[48–50]

A critical need that can be addressed through research is the establishment of technical standards and guidelines to ensure appropriate application that does not compromise the standard of care expected in face-to-face or in-person clinical encounters (e.g., different bandwidths required for different tasks). While this may paradoxically present access issues related to the need to travel to telehealth sites with appropriate equipment and infrastructure, it is important to maintain clinical standards. For example, the following findings were reported in studies of SLP telehealth applications: while the quality of sound and visual images permitted accurate judgments about most aspects of patient's speech performance, subtle features like speech breathing were more difficult to assess; adequate bandwidth and proper positioning of patients in front of the camera are important in order to visualize structures for purposes such as oromotor examinations or discriminating similar sounding phonemes by observing articulatory placement; at times, competing Internet traffic compromised audio and video quality; although a majority of participants receiving treatment remotely indicated that online delivery was acceptable, some respondents indicated that the audio and visual quality was less than adequate; occasional problems associated with connectivity were resolved by preparing patients and having a back up available such as a telephone in the room; unlike other video-streaming applications that can tolerate loss of video quality, the analysis of swallowing function requires high-fidelity video with no loss in quality. These findings provide valuable information for future telehealth applications.

Future Directions

A goal for the future is to integrate telehealth services seamlessly into routine clinical and administrative functions. As communications technologies continue to develop and progress, advances in infrastructure and software should eventually allow secure connections from patient's home. Research is needed to define standards for clinical protocols with equipment specifications (e.g., compression, resolution, and transmission quality) to support diagnostic and therapeutic procedures and goals (Research Question 1: What are minimum requirements for technology to ensure efficacious and cost-effective telehealth services?).

When guidelines and standards are established, they can be used to direct research questions and provide tools for designing research protocols[51] (Research Question 2: What assessment procedures and tests yield accurate and reliable information when delivered via telehealth to support diagnosis of communication disorders? Research Question 3: What treatment protocols yield effective and efficacious outcomes when delivered via telehealth?).

ASHA's Working Group on Telepractice[5,6,52] developed three documents that provide an excellent platform from which to embark on future telehealth applications. Indeed, the proverbial "sky is the limit" when venturing into the telehealth frontier with the vision of international collaboration to provide quality services to citizens in need. With our global network across which to connect, the potential and possibilities are virtually boundless.

Conclusion

An extensive review was conducted of the literature available on the application of telemedicine and telehealth technologies in SLP. While a significant amount of demonstrations and investigations have been reported with favorable clinician and patient response, evidence from clinical trials is needed to validate speech–language pathology telehealth protocols including technical specifications, clinical efficacy and outcomes, and economic analyses. The armamentarium of technologies available to healthcare providers including SLPs should be used to its fullest extent to enable better quality care in environments that lack the physical presence of expertise.

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APPENDIX. Summary of Telehealth Applications in Speech–Language Pathology

STUDY OR APPLICATION	PARTICIPANTS	SITE(S)	TYPE OF SERVICE	DIAGNOSIS/ DISORDER	TECHNOLOGY USED	EVALUATION & CONCLUSION*
Brady (2007)[11]	experience of a home health agency	Visiting Nurse Association Health Services in Port Huron, Michigan	telehomecare speech therapy	case report of patient with dysphagia	video and non-video units for videoconference (VC) sessions or to monitor patients	speech therapy services have proven to be the most conducive to tele-homecare; allows close monitoring and helps to determine when additional or follow-up services are needed
Brennan, Georgeadis, and Baron (2002)[10]; Brennan, Georgeadis, Baron, and Barker (2004)[8]; Georgeadis, Brennan, Barker, and Baron (2004)[43]	number: 40 23 males 17 females age: 18–70**	Rehabilitation Engineering Research Center on Telerehabilitation at the National Rehabilitation Hospital	administered Story Retelling Procedure (SRP) to measure language production and comprehension of spoken narratives	14 patients with right cerebrovascular accident (CVA), 14 with left CVA; 12 with traumatic brain injury (TBI)	computer-based video tele-conferencing (VTC) with full duplex audio and video over a high bandwidth of 10 megabits per second (Mbps) Local Area Network connection	no statistically significant difference was found on SRP performance between face-to-face (FTF) and VTC settings; 34/40 were interested in future VTC use; 6/40 "no" or "maybe" (all participants with TBI)
Carpenedo (2006)[21]; Brown and Carpenedo (2006)[46]	more than 200 patients received treatment in the speech telepractice program	Visiting Nurse Service of New York Home Care (Manhattan, Brooklyn, Queens, the Bronx)	combines service delivery via telepractice as an adjunct to in-home speech treatment visits; oral-motor, language, voice (LSVT), dysarthria, dysphagia and cognitive-communication intervention	speech disorders secondary to Parkinson's disease, communication disorders following stroke, transient ischemic attack (TIA), neurogenic dysfunction, neuromuscular dysfunction; aphasia, dysarthria	videophones	patient feedback was positive (4.2 to 4.8 on 5 point Likkert scale) rating ease of use, training received, improved overall plan of care, staff knowledge and professionalism
Clark, Dawson, Scheideman-Miller, and Post (2002)[22]	teletherapy case study of 52-year-old female with left CVA	rural Oklahoma and INTEGRIS Jim Thorpe Rehab Center	interactive telerehab (Physical Therapy, Speech-Language Pathology, Psychology, Vocational Rehab)	moderate to severe nonfluent receptive and expressive aphasia and moderate apraxia of speech secondary to left CVA	desktop videophone using plain old telephone system (POTS) at clinician site; set-top communication device using existing telephone for audio and television for video in patient's home; 18 frames per second; maximum data rate of 33.69 kilobits per second (Kbps)	after 62 SLP teletherapy sessions, patient expressed basic needs independently; FIM scores on cognitive & communication items improved; cost savings for travel; productivity savings for caregiver
County Council of Vasterbotten (n.d.)[20]	application in delivering speech therapy in Vasterbotten, Sweden	Lycksele Hospital to cottage hospitals with video technology located throughout Vasterbotten County; plan to expand to schools in rural areas	interactive speech-language rehabilitation; plan to expand to pediatric and adolescent rehabilitation	aphasia; plan to extend services to vocal problems and speech-language problems or dyslexia and "stammering"	"video technology;" described interactive and store-and-forward applications	positive results; high patient satisfaction

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APPENDIX. Summary of Telehealth Applications in Speech–Language Pathology *continued*

STUDY OR APPLICATION	PARTICIPANTS	SITE(S)	TYPE OF SERVICE	DIAGNOSIS/ DISORDER	TECHNOLOGY USED	EVALUATION & CONCLUSION*
Duffy, Werven, and Aronson (1997)[7]	number: 150 consultations 46 males 104 females age: 20–90	Mayo Clinic facilities in Minnesota, Arizona, Florida	speech-language pathology consultations	dysarthria, apraxia, aphasia, dysphonia, cognitive-communication impairment, laryngectomy, stuttering	non-compressed satellite transmissions, broadcast quality, analogue, visual equivalent of 108 Mbps	telemedicine provides medium for speech-language consultations that is reliably accurate in identifying various acquired neurogenic and psychogenic speech disorders
	number: 8 age: 35–87	project comparing FTF with remote delivery of services from Mayo Clinic in Rochester to rural community hospital in Wabasha, Minnesota	speech-language evaluation including examination of oral mechanism, motor speech and language	cerebral palsy, stroke, basilar artery aneurysm repair, TBI, multiple sclerosis	digitized low-data rate satellite transmission; 1.5 Mbps	
Forducey (2006)[36]	number: completed approximately 11,000 speech teletherapy sessions age: school-aged	Speech Teletherapy program, Oklahoma	speech-language screenings; group and individual therapy; standardized testing; IEP meetings via TC	speech-language delay/impairment, autism, fluency disorder, hearing loss	real-time, two-way interactive TC-point-to-point Internet Protocol (IP); VC endpoints with T1 or greater connections to the state technology network infrastructure	provided much-needed clinical services to students who otherwise would have minimal or no access to speech services
Georgeadis and Brennan (2003)[14]; Brennan (2006)[44]	adults	Rehabilitation Engineering Research Center on Telerehabilitation at the National Rehabilitation Hospital in Washington, DC	adult speech-language rehabilitation	speech-language and cognitive communication disorders secondary to neurologic impairment	custom software package REmote SPEech-language Cognitive-communication Treatment (RESPECT) combines live VTC features with "Virtual Desktop" via customized graphical user interface to enable clinician to administer therapy materials	[patient exhibited marked improvement with reading comprehension scores and spontaneous verbal output; patient's family noted a significant difference in communication skills]
[Baron, Hatfield, and Georgeadis (2005)[15]]	[case study]		[treatment of neurogenic communication impairment]	[moderate nonfluent aphasia and moderate-severe apraxia of speech]		
Georges, Potter, and Belz (2006)[35]		University of Kansas Hospital and a rural site in Kansas	remote, interactive modified barium swallow studies; telementoring	dysphagia	video fluoroscope attached to a Polycom F/X system at the remote site	clinicians at both sites were comfortable with the technology and studies indicated good acceptance by patients; allowed mentoring clinicians at rural site which resulted in professional growth and skill development

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APPENDIX. Summary of Telehealth Applications in Speech–Language Pathology *continued*

STUDY OR APPLICATION	PARTICIPANTS	SITE(S)	TYPE OF SERVICE	DIAGNOSIS/ DISORDER	TECHNOLOGY USED	EVALUATION & CONCLUSION*
Glykas and Chytas (2004)[42]	20 speech-language therapists delivering services to children and adults	system set up and implemented in a clinical center in Athens, Greece and accessed by users from Greece and the United Kingdom	usability study evaluating user acceptance including usefulness in therapy sessions, user friendliness, accuracy of feedback, range of uses, portability of the system, affordability	hearing impairment, voice disorders, disfluency, learning disabilities, cleft palate, physical disabilities, speech-language delay and disorder, neurological disorder, others	web-based system of technology-assisted speech-language therapy tools and visual speech aids including information, tests, report templates, database for storing patient records and information, e-learning applications; active server pages (ASP) technology	"Telelogos" provides potential to supplement traditional delivery of speech therapy services; enhances access to information and resources, empowers patients to make informed healthcare decisions, streamlines organizational processes and transactions, and improves quality, value, and patient satisfaction
Hill, Theodoros, Russell, Cahill, Ward, and Clark (2006)[16]	number: 19 age: 18–78	university and hospital laboratory in Australia	counterbalanced, repeated measures design comparing perceptual assessments of motor speech disorders administered FTF and in an online environment	dysarthria associated with an acquired neurological impairment	real-time VTC Internet 128 Kbps IP connection; store-and-forward video and audio data	online assessment of motor speech disorders using Internet-based system is feasible; more reliable assessment is possible with additional refinement of technology and assessment protocols; measurements of severity of dysarthria, % intelligibility in sentences, and most perceptual ratings fell within clinically acceptable criteria; several online ratings on the Frenchay Dysarthria Assessment were not comparable to FTF
Houn and Trottier (2003)[18]	number: 20	Speech Therapy Department at St. Alexius Medical Center in Bismarck, North Dakota and 7 medical centers and 1 school	speech-language pathology services	stroke reported as example	full-motion video consultation with spontaneous audio and video interaction; written material faxed or mailed in advance; Elmo overhead projector stand	clinicians reported "a very positive experience and appears to be beneficial for everyone involved"; provided opportunity to reach patients who would otherwise not receive services

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APPENDIX. Summary of Telehealth Applications in Speech–Language Pathology *continued*

STUDY OR APPLICATION	PARTICIPANTS	SITE(S)	TYPE OF SERVICE	DIAGNOSIS/ DISORDER	TECHNOLOGY USED	EVALUATION & CONCLUSION*
Kully (2000)[27]; [Kully (2002)[28]]	case report of 38-year-old male [n = 80 sessions age = 3–38] (aim was to gather preliminary experience to determine feasibility and clinical practice issues)	Telehealth Centre at the University of Alberta's Faculty of Rehabilitation Medicine and rural telehealth center in Two Hills, Alberta, Canada	follow-up sessions after completing intensive 3-week treatment program at the Institute for Stuttering Treatment and Research in Edmonton; involved practice of specific speech skills/strategies and discussion aimed at facilitating self-management and problem-solving skills [combination of in-clinic and telehealth visits]	stuttering	(VC system employed a digital line with a data rate of 770 Kbps; document camera relayed graphic images) [primarily through ISDN lines with bandwidth from 128 to 384 Kbps]	verbal reports of both patient and clinician were positive; patient reported satisfaction with structure of session and effectiveness of feedback; clinician evaluated session outcomes as satisfactory; high-quality of sound and visual images permitted accurate judgments about most aspects of patient's speech performance
Lewis (2006)[23]	15 children	Australia	Lidcombe Program of Early Stuttering Intervention	stuttering	"low-tech telehealth adaptation" including training videos, recorded speech samples, telephone consultations, e-mail	telehealth delivery required more lengthy treatment times and higher cost than clinic-based delivery; however it is a viable, effective and acceptable option to improve access to services
McCullough (2001)[40]	4 preschool children with Down syndrome and 1 preschool child with Cornelia de Lange syndrome	nursery/clinic and home in Belfast	27 teletherapy sessions focused on parent training (20 to 35 minutes per session)	communication disorders in children with special needs	home: TV/video recorder, motion media Setop box/PTZ camera clinic: PC, PTZ camera, VCON system connected via ISDN2 line (128 Kbps)	user friendly and reliable for both parents and therapists; telemedicine judged to be a viable and effective treatment option for children with special needs; "children related to the system in a natural and spontaneous manner"
Madsen and Rollings (2005)[37]	50 students in 9 schools	North Dakota Center for Persons with Disabilities at Minot State University and rural schools in North Dakota	speech and language therapy		interactive VC: Windows XP with Pentium III processors and 256 MB of memory; T1 Internet access connection	analysis of data collected during online speech-language therapy indicated telehealth as effective model for providing articulation and language therapy

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APPENDIX. Summary of Telehealth Applications in Speech–Language Pathology *continued*

STUDY OR APPLICATION	PARTICIPANTS	SITE(S)	TYPE OF SERVICE	DIAGNOSIS/ DISORDER	TECHNOLOGY USED	EVALUATION & CONCLUSION*
Mashima, Birkmire-Peters, Holtel, and Syms (1999)[9]; Mashima, Birkmire-Peters, Syms, Holtel, Burgess, and Peters (2003)[30]	number: 51 age: 18–85	hard-wired video camera and monitor in adjacent rooms compared with face-to-face	treatment of voice disorders	vocal nodules, vocal fold edema, vocal fold paralysis, vocal hyperfunction without pathology	real-time interaction via video camera and monitor sharing voice analysis software via NetMeeting	no difference in treatment outcomes between telehealth and face-to-face conditions
[Mashima and Holtel (2005)[31]]	[preliminary data]	[military medical facilities in Hawaii and Japan]	[deployment of remote units to treat voice disorders]		[VTC with Tandberg 880 via ISDN lines at 384 Kbps bandwidth]	
Myers (2005)[33]	number: 3 case presentations age: 55, 45, 76	specialty cancer care center and local health care facilities in Canada	alaryngeal speech and swallowing therapy, management of tracheoesophageal voice prosthesis, psychosocial support, education of patient/ family/ healthcare providers	aphonia, dysphonia, dysphagia secondary to head and neck cancer	VC; technology requirements for patients with head and neck cancer include availability of close-up; high-resolution video and still images; adequate lighting for accurate assessment of stomas, prosthesis status, and skin and mucosal properties; room with acceptable acoustics to assess speech intelligibility	utility of telehealth in management of individuals with head and neck cancer appears promising; recommend research to evaluate clinical effectiveness of speech-language pathology services for this patient population as well as other clinical populations
O'Brian, Packman, and Onslow (2008)[25]	number: 10 8 males 2 females age: 22–48	Australian Stuttering Research Centre and participants' naturalistic settings (e.g., home, work, university)	Phase I trial to investigate the viability of telehealth delivery of the Camperdown Program for adults who stutter	stuttering	telephone and e-mail	participants showed an 82% reduction in stuttering frequency immediately after treatment and a 74% reduction 6 months after treatment; preliminary data suggest that telehealth Camperdown has potential to provide efficacious treatment for clients who do not have access to traditional FTF treatment
Palsbo (2007)[17]	24 adults; 18 males 6 females age: 25–81	National Rehabilitation Hospital in Washington, DC; INTEGRIS/ Jim Thorpe Rehabilitation Hospital in Oklahoma City	randomized, double-crossover agreement design using pairs of FTF and remote SLP evaluators	post-stroke (time since stroke ranged from 2 months to 15 years; median = 1 year)	VTC at 384 Kbps	results suggested that assessment of a patient's functional communication using VTC is equivalent to a FTF encounter

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APPENDIX. Summary of Telehealth Applications in Speech–Language Pathology *continued*

STUDY OR APPLICATION	PARTICIPANTS	SITE(S)	TYPE OF SERVICE	DIAGNOSIS/ DISORDER	TECHNOLOGY USED	EVALUATION & CONCLUSION*
Perlman and Witthawaskul (2002)[34]	project to design a program to conduct modified barium swallow studies remotely	University of Illinois at Urbana-Champaign and a fluoroscopy suite in a hospital	real-time, remote, interactive evaluation of oral/ pharyngeal swallowing function via an Internet system; video recording with back-up store-and-forward	swallowing disorder	PCs at remote and controlling sites connected via broadband Internet (IP); T1 with maximum throughput at 1.5 Mbps (hospital); 10 Mbps Ethernet LAN (university lab)	preliminary work has proceeded well; system will eventually permit creation of a dysphagia portal and databank for secured, worldwide access for research and education, and serve as a virtual workspace for experts to collaborate
Pierrakeas, Georgopoulos, and Malandraki (2005)[41]	application of online collaborative environments for speech therapy	Greece	group therapy; mentoring; continuing education; clinical consulting in multidisciplinary teams	articulation disorders, aphasia, stuttering	real-time interactive and store-and-forward components; real-time multipoint VC with connections as low as 28.8 Kbps; PC with video and audio capabilities and dial-up connection; online collaboration environments	telemedicine provides patients in rural and remote areas with access to quality rehabilitation services that are sufficient, accessible, and user-friendly leading to new possibilities in comprehensive and long-term, cost-effective diagnosis and therapy
Rose, Furner, Hall, Montgomery, Katsavras, and Clarke (2000)[39]	18 school-aged children	nursery in Salisbury, 4 primary schools in Wiltshire, UK	therapy support services for children entering mainstream schooling	"communication difficulties"	real-time interactive VTC via 3 x ISDN2 lines	VC technology can be used to support the delivery of speech and language therapy services into schools
Savard, Borstad, Tkachuck, Lauderdale, and Conroy (2003)[50]	number: 75 age: 9 months–86 years (not all received SLP services); 1 case study of pediatric neurologic consult including speech-language assessment	Sister Kenny Rehabilitation Institute in Minneapolis, MN; National Rehabilitation Hospital in Washington, D.C.; LBJ Tropical Medical Center in American Samoa	telerehabilitation consultations included physiatrists, physical therapists, occupational therapists, speech-language pathologists, recreation specialists, equipment specialists, orthotists	neurologic diagnoses including CVA, Parkinson's disease, spinal cord injury, cerebral palsy, traumatic brain injury, amyotrophic lateral sclerosis, multiple sclerosis, muscular dystrophy	Polycom ViewStation; ISDN (128-384 Kbps), IP (128-768 Kbps); satellite	"SLP rated the clinical effectiveness of the encounter as good; limitations identified were lack of evaluation and follow-up tools validated for care delivery via VTC"
Sicotte, Lehoux, Fortier-Blanc, and Leblanc (2003)[26]	number: 6 age: 3–19	Montreal pediatric tertiary care center and a local primary care centre in a remote area innorthern Quebec, Canada	assessment and treatment for persons who stuttered and were unable to receive services within their community	stuttering	VC unit, reception frequencies varied between 50 Hz and 7.0 kHz; transmission took place at a maximum of 768 Kbps via an intranet	patient and clinician satisfaction were high, participants considered the intervention to be effective; patients' perceptions regarding a decrease in stuttering were favorable

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APPENDIX. Summary of Telehealth Applications in Speech–Language Pathology *continued*

STUDY OR APPLICATION	PARTICIPANTS	SITE(S)	TYPE OF SERVICE	DIAGNOSIS/ DISORDER	TECHNOLOGY USED	EVALUATION & CONCLUSION*
Theodoros, Constantinescu, Russell, Ward, Wilson, and Wootton (2006)[29]	number: 10 8 males 2 females age: mean = 73, SD = 10	clinician in one room and participant in another room connected via VC link	Lee Silverman Voice Treatment (LSVT) for speech disorder associated with Parkinson's disease (PD)	mild to moderate-severe hypokinetic dysarthria secondary to idiopathic PD	VC via a 128 Kbps Internet link; store-and-forward, text transfer	results demonstrated the feasibility of an Internet-based application to deliver the LSVT; further research needed involving larger numbers of participants
Tindall and Wright (2006)[19]	number: 1 age: 57	Veterans Affairs Medical Center in Lexington, Kentucky and patient's home	treatment for anomia	Broca's aphasia; left CVA	videophones	patient responded well to therapy delivered via videophones; no assistance needed to operate the videophone; positive feedback from spouse
Vaughn (1976)[12]	adults	Veterans Affairs Hospital in Birmingham, Alabama	supplementary and reinforcement services on an outreach basis for veterans with communication disorders	voice disorders, alaryngeal speech, articulation disorders, stuttering, aphasia, dysarthria, auditory disturbances	Tel-Communicology system utilized telephonic systems, programmed materials and educational media	eliminated travel time, reduced travel costs, and increased frequency of therapy contacts
Waite, Cahill, Theodoros, Busuttin, and Russell (2006)[38]	number: 6 age: 4:3–6:8 (mean = 5.3)	University of Queensland; pilot study comparing FTF assessment vs. "online" clinician in another room within the same building	assessment of single-word articulation, speech intelligibility in conversation, and oromotor structure and function	mild to moderately severe speech disorder	VTC through a 128 Kbps Internet link; transfer of pre-recorded video and audio data to the online clinician	high level of agreement between online and FTF assessment; results provided preliminary evidence for the feasibility of an Internet-based assessment of childhood speech disorders
Ward, White, Russell, Theodoros, Kuhl, Nelson, and Peters (2007)[32]	number: 20 17 males 3 females age: 41–70; mean = 61	separate rooms within same hospital in Australia	comparison of simultaneous online and FTF assessments of oromotor, swallowing, and communication in patients post laryngectomy to validate Internet-based telerehabilitation option	surgical removal of larynx due to cancer	assessments conducted at bandwidth of 128 Kbps; specialized VC software allowed real-time objective evaluation, captured high-quality video and audio recordings independent of VC tools, data sharing, and Web camera control	patients were 100% satisfied with usability of system and quality of services they received; there was greater than 80% agreement between online and FTF clinician for all variables relating to oromotor function, swallowing status, and communication ability; however, visualization of the stoma was poor; clinician satisfaction with the functionality of the system was low, although their ratings were high for ease of use and potential for telerehab as service delivery method

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APPENDIX. Summary of Telehealth Applications in Speech–Language Pathology *continued*

STUDY OR APPLICATION	PARTICIPANTS	SITE(S)	TYPE OF SERVICE	DIAGNOSIS/ DISORDER	TECHNOLOGY USED	EVALUATION & CONCLUSION*
Wertz, Dronkers, Bernstein-Ellis, Sterling, Shubitowski, Elman, Shenaut, Knight, and Deal (1992)[13]	number: 72 age: adults	simulation study comparing FTF vs. remote conditions; Veterans Affairs Medical Center in Martinez, California	appraisal and diagnosis of neurogenic communication disorders	aphasia, apraxia, dysarthria, dementia, TBI, confusion, right hemisphere	closed circuit television; computer-controlled video laserdisc over the telephone	agreement in diagnosis among appraisal conditions (93% to 94%) and close approximation of patient performance on appraisal measures among conditions suggest that either television or computer-controlled video laserdisc by telephone could be substituted for FTF appraisal and diagnosis
Wilson, Onslow, and Lincoln (2004)[24]	number: 5 age: 3 yrs, 5 mos to 5 yrs, 7 mos	Australia; low-tech telehealth adaptation of the Lidcombe Program of Early Stuttering Intervention	therapy for childhood stuttering	stuttering	telephone calls; recordings of speech samples mailed to clinician	telehealth adaptation of the Lidcombe Program may be clinically viable and able to produce satisfactory clinical outcomes; delivery via VTC should be investigated

*As reported by investigators.
**Age reported in years unless otherwise indicated.